MINUTES AND PROCEEDINGS

of the

ARMY-NAVY-OSRD VISION COMMITTEE

NINTH MEETING - 10 JANUARY 1945

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ARMY - NAVY - OSRD VISION COMMITTEE

10 January 1945

Amphibious Training Command
U. S. Atlantic Fleet
Norfolk, Virginia

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U.S. Armed Forces - NRC Vision Committee

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ARMY - NAVY - OSRD VISION COMMITTEE

MINUTES

Ninth Meeting
Amphibious Training Command
U. S. Atlantic Fleet
Norfolk, Virginia
10 January 1945

The following were present:

ARMY	AAF	(A)Lt. Walter Romejko
	AGF	Lt. Col. Allan L. Feldman, Ground Requirements Section
	AGO	(M)Dr. Edwin R. Henry
	Engrs	(M)Major S. K. Guth
	Ord	(M)Lt. Col. R. S. Cranmer
		(A)Mr. John E. Darr
	SG	(A)Major M. E. Randolph
	WDLO	Major H. Noble, Liaison Officer with NDRC
NAVY	BuAer	(CM)Lt. Comdr. David F. Leavitt
	BuMed	Lt. Harry Older, Aviation Psychology Section
		Lt. John A. Bromer, Franklin Institute, Philadelphia
	BuOrd	(A)Lt. Nathan H. Pulling
		(CM)Lt. Philip Nolan
		Comdr. R. M. Nixon, Naval Gun Factory
		Mr. S. G. Hall, Naval Gun Factory
		Ensign Anne Bochan
	BuPers	Lt. J. C. Snidecor, Standards and Curriculum Section
	BuShips	(CM)Comdr. Charles Bittinger
		Lt. Comdr. R. M. Langer, Physics Research Section
	I C Bd	(M)Lt. Comdr. George W. Dyson
	NMRI	(CM)Dr. Harold F. Blum
	NRL	(M)Dr. E. O. Hulburt
		(A)Dr. Richard Tousey
	SONRD	Comdr. R. D. Conrad
	SubBase	(M)Capt. C. W. Shilling
	ATC	Capt. C. F. Erck, Commanding Officer, ATB, Camp Bradford
		Comdr. H. D. Fuller, Training Officer, ATB, Camp Bradford
		Comdr. C. B. Stringfellow (MC) S.M.O., ATB, Camp Bradford
		Comdr. W. R. Burns (DC) S.D.O., ATB, Camp Bradford
		Lt. Comdr. E. A. Caredis, Executive Officer, ATB, Camp Bradford
		Lt. Comdr. F. M. Bannon (MC), ATB, Camp Bradford
		Lt. Jerome Brock, ATB, Camp Bradford
		Capt. S. H. White (MC), S.M.O., Little Creek

Lt. Comdr. M. M. Champlin, Asst. Chief of Staff, ATC, Norfolk
Lt. Comdr. L. L. Mackenzie, Asst. Force Surg., ATC, Norfolk
Lt. J. H. Sulzman (MC) ATC, Norfolk
Ch. Pharm. Roy Whitehurst (HC) ATC, Norfolk
Lt. C. W. DeWitt, ATC, Norfolk

Ch. Pharm. J. R. Pence (HC) Service Force, U. S. Atlantic Fleet

Lt. Col. M. O'C Horgan (RE) British Liaison, ATC
NAS Lt. Dean A. Ambrose, Dispensary, NAS, Corpus Christi, Texas
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Dr. E. S. Lamar, Operations Research Group

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APP Dr. Dael Wolfle, Applied Psychology Panel, NDRC
OSRD (M)Dr. Donald G. Marquis

Major A. H. Neufeld, Royal Canadian Army Medical Corps
Mr. Harry S. Purnell, Technical Development Division, CAA

1. Night vision testing and night lookout training facilities were demonstrated at Amphibious Training Base, Camp Bradford. 9*

   A. Night Vision Obstacle Training Maze. 9

   B. Night Lookout Trainer adapted to landfall observation training. 11

   C. Modified lighting of Night Lookout Training Stage. 12

   D. Animated Ship-to-Shore Panel. 13

   E. Ortho-Rater. 13

   F. Livingston Tangent Screen. 14

2. Lt. Comdr. Champlin, representing Admiral Rockwell, and Capt. Erck welcomed the Vision Committee to the Amphibious Training Command.

3. The chairman called for corrections or alterations in the Minutes and Proceedings of the eighth meeting. The

*Numbers at the right refer to pages in the Proceedings on which the full report or discussion is presented.

following corrections should be made: On the title page and pp. 5 and 9, ninth meeting should read eighth meeting. The following lines should be inserted on p. 18, paragraph 4, line 6, following the word "umbra":

> "without sharp boundaries. The borders of the square become sharper as the distance from the eyes to the strips is increased and as the diameter of the pupil decreases. The diameter of the pupil can be decreased by transmitting more light through the goggles but this presents very real disadvantages. The distance from the eyes to the lenses can be increased, but beyond 45 to 50 mm. clumsy devices tend to result which also have the disadvantage of a narrowed visual field. A distance of around 40 mm. seems workable, and at this distance 6 mm. strips used in bright sun give an umbra"

4. Dr. Kimball discussed the work of Operations Research Group, U. S. Navy, on problems of visual search and pointed out the need and possible methods for gathering more data. 16

5. Lt. Comdr. Dyson requested an opinion from the Committee concerning the effect of a green signal light on dark adaptation. 23

6. A ship-to-shore landing demonstration was observed at Amphibious Training Base, Little Creek.

ARMY - NAVY - OSRD VISION COMMITTEE

PROCEEDINGS

Ninth Meeting
Amphibious Training Command
U. S. Atlantic Fleet
Norfolk, Virginia
10 January 1945

1. NIGHT VISION PROGRAM AT CAMP BRADFORD

The following discussion of night vision testing and training facilities demonstrated at Camp Bradford was prepared by Lt. John Sulzman.

The night vision testing and night lookout training facilities demonstrated at Amphibious Training Base, Camp Bradford, are representative of other Amphibious Training Bases. Buildings have been planned and constructed for this particular purpose with special emphasis on light-proofing and adequate ventilation. In addition, two complete electric circuits are installed in each building, one for white and one for red lights.

The new building at Camp Bradford contains two Night Lookout Training Stages which permit the instruction of an entire LST crew every half day or four-hour period. The main lecture room in this building seats about 125 officers and men, and adjoining this space are adaptometer rooms for night vision testing.

While officers and men are adapting in the blacked-out lecture room, motion pictures are projected through a filter of red plastic made of the same material as that used in dark adaptation goggles. The goggles are demonstrated, but their use is not necessary because of the plastic in the apertures of the projection room. This is a decided factor in warm weather since it adds to the comfort of the men and eliminates "fogging".

During the motion picture program, personnel are tested for night vision after a short interval in complete darkness just preceeding the test. Officers and men, coming from the testing rooms, are directed to the Night Vision Obstacle Training Course by ushers.

A. LOOKOUT MAZE TEACHES NIGHT VISION SKILL TO AMPHIBIOUS PERSONNEL

Shin-busters, electrified posts, and dead-end corridors, the familiar impedimenta of an amusement park maze, have been put to

use by the Navy's Amphibious Training Command in a training device designed to sharpen the night vision of the men who will storm enemy shores.

With the added hazard of almost total darkness, trainees learn to negotiate this Night Vision Obstacle Maze with the speed of a sprinter. The average time for a man whose night vision has been well trained is from three and one-half to five minutes.

The maze was devised to add to the broad night vision training program, necessary for amphibious forces, the additional training in visual acuteness which will enable the men to circumvent unknown obstacles. It was realized by training authorities that these men would be sent on hazardous missions in which every possible trick was essential, and every trick learned about seeing in the dark might well spell the difference between success and failure.

Engineering, medical, and training experts cooperated in designing the maze, after agreeing that it should be large enough to provide an extensive test of night vision acuteness, dim enough so that the sense of touch could not be used as an aid, and interesting enough so that trainees would enjoy the maze despite its hazards. The hazards themselves were planned to be difficult and to involve a certain amount of physical inconvenience if night vision techniques were disregarded.

Before entering the maze, the trainees' eyes are dark-adapted. As each man awaits his turn to start running through the maze, he is given a short description of the hazards and told what precautions to observe. Then he is led into a completely darkened "confusion room," the five exits of which look exactly alike.

Passing through any one of the openings, the trainee enters a dimly lighted corridor which may be free to passage or may be blocked by a sliding panel. If the trainee uses his eyes properly, he is able to see these panels without advancing beyond the openings from the "confusion room."

Progress beyond this point introduces the man into a dimly lighted room that is completely partitioned into corridors to form a maze. The tendency to feel one's way is predominant, so in order to overcome this, the tops of all partitions are electrified with sufficient current to produce a decided sting but no injury if hands are used instead of eyes.

After leaving the maze, the trainee enters a corridor which turns at right angles, across which lines have been draped. The trainee must pick his way through these much as he would travel through brush and trees with protruding low branches. Around the

first turn of the corridor, three steps are encountered, all of which have a different rise. After mounting, or stumbling up these steps, the trainee proceeds along a ramp to the next room.

The floor of the next room has been flooded. The trainee has to cross the water on a series of dimly illuminated stepping stones of varying sizes and shapes.

Then, after completing the water hazard, the man enters the last room — a room containing closely nested and electrified posts, sand bag barriers, stumbling hazards, and a maze of lines stretched between posts. The trainee can take any path he desires through this series of obstacles, but with the proper use of the eyes, the shortest and easiest route is barely visible. A dim colored exit light indicates the termination of the course.

Throughout the rooms, an effort has been made to produce the same amount of lighting as would be available on a clear night.

Men who successfully negotiate the obstacle training maze in average time have proven that, through proper use of the eyes, obstacles such as assault troops face, even in very dim illumination, can be overcome.

B. THE ADAPTATION OF THE NIGHT LOOKOUT TRAINER TO LANDFALL OBSERVATION TRAINING (NavPers 170090)

Amphibious operations are usually initiated in darkness, and it is essential that individual landing craft arrive at the precise point at the exact time set forth in the operational plan. It is imperative that specialized training simulating actual landing conditions be provided for combat crews who will undertake nocturnal amphibious assault. The ability to recognize and identify a particular landfall under low levels of illumination is important.

With this in mind a series of problems has been designed utilizing scaled landscape silhouettes and briefing maps to be used in conjunction with the existing Night Lookout Trainer. Properly illuminated through the west horizon lights of the trainer and some additional special lighting units, these landfall silhouettes will approximate the conditions encountered by men aboard a landing craft approaching a hostile shore at night or before dawn.

Three problems designed to present typical landing situations, progressively more difficult than the previous one, are provided. Each problem consists of three sets of silhouettes which run the 32' length of the horizontal shelf on the Night Lookout Trainer. The first two sets locate the landfall at 3,000 or 4,000 yards and at 500 to 800 yards. The third set locates the transport area at 4,000 to 8,000 yards. A stepped hinge unit is provided to facilitate

the rapid changing of silhouettes within a problem. Switch control beachmarker lights are found in problems 1 and 2 plus a luminous surf effect achieved through the use of ultraviolet light and fluorescent paint. Problem 1 provides obvious landmarks plus the assistance of beachlights and definite breaks in the surf to indicate passages through reefs. Problem 3 offers a minimum of distinguishing features and will, therefore, demand a more keen memory-perception. In addition changes of intensity of the west horizon lights will provide more or less intensity.

It will be seen readily that the approach to landfall observation training presented herein can easily be elaborated upon. When serial and water level photographs and contour and relief maps are available, related landscape silhouettes can be designed to provide problems that can be very thoroughly briefed. Additional beachmarker, dump, range, and obstruction lights can be used. It would be advantageous to have on hand problems that would provide all possible typical landfall situations.

C. MODIFICATION OF THE NIGHT LOOKOUT TRAINING STAGE

Upon the recommendations of the Medical Research Department of the U. S. Submarine Base, New London, Conn., the entire back panel of the Night Lookout Training Stage was repainted with two coats of flat white paint, and the top of the stage itself was painted with two coats of gray paint (ratio eight parts white to one part flat black). This modification necessitated the following changes in lighting:

(a) Installation of blue-coated bulbs (10 watts) in strip-lights of entire eastern horizon.

(b) Dimming down lower the light bulbs of four "fires at sea", "moonbeam", western horizon and bearing indicators.

As the moonbeam is brought up in brightness, it cannot be seen until classes are dark-adapted. This fact is used in demonstrating the course of dark-adaptation. The western horizon is used in customary fashion to demonstrate the effect of light and background contrast, and the difficulty of vision at the same brightness level using the eastern horizon.

As the eastern horizon is brought up gradually, a number of objects appear on the horizon, which later take definite shapes and are finally seen as ships. Blue lighting renders this effect much more realistic, and offers a greater range for testing identification.

In order to test and impress personnel with the importance of alertness, lightning, gunfire, and "fire-at-sea" effects are shown. Men report the number of ships or objects shown in silhouette

by the flash. Some of these effects are also used to give practice in reporting relative bearings. At the same time, the bearing indicator lights are useful in correcting the men reporting.

In general, the modification in lighting and painting of the Night Lookout Training Stage lends greater realism to the training, at the same time making contact and identification reports more difficult and requiring more effective use of night vision technique.

D. ANIMATED SHIP-TO-SHORE PANEL (NavPers 210024)

This is a training aid intended for amphibious training, which teaches the essential tactics of a ship-to-shore landing.

It is composed of an 8' x 4' x 4½" wired panel demonstrating the assembly and progressive movement of small boats in a landing operation. Beneath the translucent plastic face of the panel, recurring light flashes, set in motion from a control board, simulate ship movements.

E. ORTHO-RATER

The Bausch and Lomb Ortho-Rater is an optical device for measuring certain individual characteristics of vision as described below. In the U. S. Navy it has been approved as a part of the classification process. Only raw scores are recorded. The test is given as a screening method for the purpose of selecting individuals on the basis of visual performance for specified billets.

The vision tests incorporated are those found to be best adapted for rapid and convenient testing in industry. They include the tests recommended for industrial classification by a committee of the American Medical Association. Each test represents one aspect of visual performance or visual skill. None of these tests is refractive or diagnostic in the clinical sense.

Norms have been established for these tests in terms of scores obtained on these tests rather than in terms of corresponding clinical tests. Tests in the "distance" drum are at the optical equivalent of eight meters distance. Tests in the "near" drum are at a downward angle and at the optical equivalent of 13 inches distance from the lenses of the instrument (approximately 14 inches from the first nodal point of the eye).

Acuity is a measure of the smallest perceptible detail in black and white at a specified distance. It is tested and recorded separately for both eyes, right eye, and left eye, without closure or occlusion of either eye, by means of separate but fusible test fields for the two eyes. The three acuity test slides are dupli-

cated, in optically equivalent sizes, at the 8-meter and the 13-inch optical distances.

Phoria measurements indicate the lateral and vertical angles between the visual axes of the two eyes when they are not required to maintain coincidence on any single point of fixation, but with the eyes focussed for a specific distance. Tests are made both at the 8-meter and 13-inch optical distances. Each of these phoria scales extends continuously from one extreme through the "normal" to the other extreme.

Depth perception (stereopsis) is a measure of the minimum perceived distance of two objects when all cues are eliminated except binocular parallax. This test is made only at the 8-meter distance.

Color discrimination is a measure of the least difference between colors, in different combinations, that can be perceived — entirely apart from any need for recognizing, naming, or matching specific colors. This test is made only at the 8-meter distance.

Doubtful individuals are referred to the medical department for further examination.

F. LIVINGSTON TANGENT SCREEN

Air Commodore Livingston states that a study of central scotomata and peripheral fields by the use of self-luminous test objects at rod level against a tangent screen at one meter distance, and in absolute darkness, is indicative of night visual capacity.

A Bjerrum tangent screen is used, but instead of the usual head rest to maintain steady visual fixation, a red-light tube has been designed in such a way that when the line of gaze moves off the fixation point of red light, the latter cannot be seen until the eye is brought back to fixation. The red light is emitted from the bottom of a very narrow black tube suitably baffled.

The test room must be completely dark and the subject completely dark-adapted. Luminous test objects at rod levels are placed in a holder, and a central visual field is mapped out at one or more levels of brightness of test objects. Each visual field is plotted by means of glass-headed pins of different colors on the screen, which is marked out in degrees by paint spots. These spots, which facilitate the transfer of results to a chart paper, are invisible and do not distract attention.

In the performance of the test, the small, faintly-luminous test objects are moved across the screen in a specified manner, the subject stating when they can be seen, and when they cannot be perceived. Since the brightness of the test objects is of a value below

that capable of provoking cone sensation, the results are expressed in terms of rod vision.

Certain characteristic features are revealed:

(a) A general enlargement of the blind spot, with greater detail of contour.

(b) A central scotoma, commonly $2^{\circ} - 3^{\circ}$ in the transverse axis, and $1\frac{1}{2}^{\circ} - 2^{\circ}$ vertically.

(c) The occurrence of a scotomatous area roughly triangular in form, apex down in the extreme upper field, in about 20 per cent of cases.

(d) The presence of an area of heightened rod sensitivity in the form of a circle around the fixation point.

(e) A contraction of the field, if the luminosity of the test-object is sufficiently reduced.

Livingston feels that scotometry, employing self-luminous test objects and a red fixation light, appears to reveal defects in the central field of vision which cannot readily be found by customary procedures.

4. PROBLEMS OF VISUAL SEARCH

The following report was prepared by Dr. G. E. Kimball and Dr. E. S. Lamar, Operations Research Group, U. S. Navy, and presented by Dr. Kimball.

1. Introduction. As anyone who has done even a little flying knows, ships have a bewildering habit of suddenly materializing almost directly under a plane. And everyone who has heard of Rickenbacker knows that a plane may easily fly directly over a life-raft in clear weather without sighting it. These evident facts are clear indication that the efficacy of visual search from the air cannot be evaluated on any such simple basis as the assumption that every object within a certain maximum range, calculated from such considerations as contrast, size, background brightness, and meteorological scattering coefficient, can and will be seen.

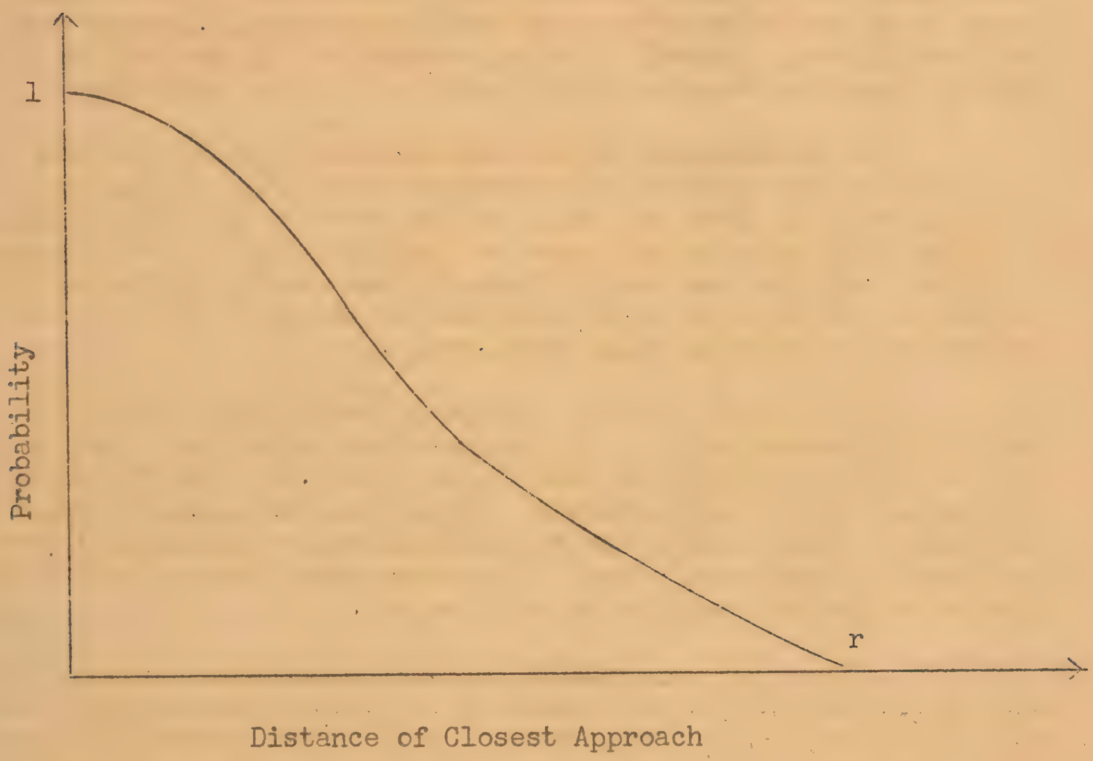
Nor is the situation in regard to lookouts on ships any better, Too often planes have been detected only when they were almost ready to drop their bombs. In fact there have been cases where the first warning a ship has had of an approaching plane has been the noise of a bomb exploding. Ships often, particularly at night, fail to see other ships for considerable lengths of time after the moment when visual detection has become possible.

This is in no way intended as a criticism of our present lookouts, or methods of lookout training. The same effect would exist in some degree no matter how many lookouts were placed on watch, and no matter how well they were chosen and trained.

2. The Detection Curve. The situation may be expressed mathematically by means of what we call the detection curve. This is simply a plot of the probability of sighting a given target, in given visibility conditions, against the distance of closest approach as the target passes by the searching craft. Such a curve is shown in Figure 1. If x, the distance of closest approach, is greater than r, the maximum range of visual detection, the probability of detection is 0. If x is slightly smaller than r, the object is in view for a short time, and there is a small probability of detection. As x becomes still smaller, the probability rises, and for small values x approaches unity.

A knowledge of the exact shape of this curve is a prerequisite for the exact analysis of a search plan. The most important feature of the curve is its area. It is easily seen that, if target motion is neglected, the number of contacts made per unit length of track in an area of unit target density is just equal to twice the area under the detection curve. This is usally called the sweep width.

Figure 1: Typical Detection Curve



In some of the simpler cases the sweep width is all that is needed to evaluate the efficacy of a plan, but in more complicated examples we must know the detection curve in detail.

For visual search the detection curve depends on many variables. These include the nature of the target, the meteorological conditions of visibility and background brightness, the speed of the searching craft, its altitude (in the case of aircraft), the number of lookouts, and the scanning procedure used. With so many variables a purely operational analysis to determine the shape of the detection curve becomes impractical: for under any one set of conditions the number of contacts falls too low for the straightforward application of statistical methods.

3. Available Data. This being the case, we have attempted to make use of such laboratory data as are available. On the maximum range of detection considerable work has been done. The experiments of Cobb and Moss (Jour. Frank. Inst., 1928, 205, 831) are now classical. Further measurements have been made by Craik in England and published by the Operations Research Section of Coastal Command. The subject is being studied exhaustively at the Tiffany Foundation under the auspices of the NDRC (Division 16). Measurements of the effect of target shape are being made at Columbia University. A program on the visibility of aircraft is being carried out by the Navy at Patuxent. There is probably other work with which we are not acquainted.

But measurements of the maximum range are not enough. They tell us the point at which the detection curve falls to 0, but little or nothing about the shape of the curve inside this limit. To obtain this shape we must know not only how far away we can see an object, but also how long it takes to see an object when it lies inside the maximum range. If such time measurements were available, the rest of the problem could be solved.

The pick-up time for a target depends primarily on the size of the perceptive area of the eye within which the image must fall on a given fixation in order to be seen. For cone vision at the maximum range this perceptive area is the fovea, but at shorter ranges it becomes larger, and fewer fixations are necessary before the target is detected. Hence the pick-up time becomes shorter and shorter as targets come closer and closer.

A number of experiments on this perceptive area have been made by Craik. If θ is the radius of the perceptive area (in degrees), α is the visual angle (in minutes), and C is the contrast (in per cent), Craik's data are represented quite well by the equation

$$C = 1.9\sqrt{\theta} + 190/\alpha^2$$

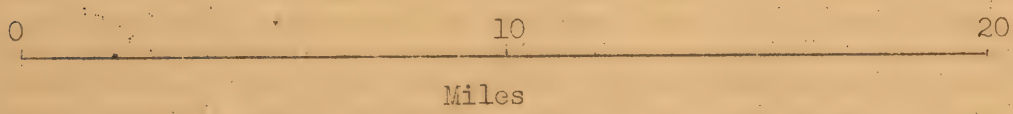
Craik has shown that, at least for line scanning, and for targets on or near the scanning line, the pick-up time is given quite well by the assumption that there is a constant probability of detecting the target wherever the observer fixates in such a way that the target image is within the perceptive area. The value of this probability was found to be roughly 1/8.

4. Scanning Lobes. In the usual type of scanning, a lookout scans along an arc at the center of which he stands. Each time he fixates there is an area on the surface of the ocean within which the target must lie if it is to be detected on that fixation. Knowing the size and intrinisic contrast of the target, we may calculate its visual angle and actual contrast as seen from different distances, and from these and the radius of the perceptive area, we may find the

Figure 2: Typical Visual Lobes. Observer at 2000 ft. altitude. Submarine target.

a. Unlimited Visibility

b. Visibility 10 Miles



limits of this area on the ocean. Following radar and sonar terminology this might be called the visual lobe. A typical lobe calculated from Craik's data is shown in Figure 2. The shape and size of this lobe is determined again by the usual factors: size and intrinsic contrast of target, background brightness, meteorological visibility, the height of the observer, and the distance of the point of fixation from the observer. It also depends on whether the object is perpendicular to the ocean (as the sides of a ship) or a horizontal surface (e.g. a wake). In some cases (for example, from a very high airplane, with a point of fixation chosen too far from the lookout) the lobe breaks into two separated regions.

As the lookout scans, this lobe is rotated from one position to another. Only when the lobe falls on the target is there an opportunity for the target to be detected. Because of the narrowness of the tip of the lobe, the chance of detecting a target near the extreme range is small, but as the target becomes nearer, the chance per fixation steadily increases. If we accept Craik's figure of 1/8 for the probability that a target will be detected if it is within the lobe on a given fixation, and if we know how many times per second the lookouts fixate, we may then carry through the complete calculation of the detection curve.

There is not time to discuss scanning methods here, but it should be pointed out that there are some serious problems in this connection. For example, slow scanning is more thorough than fast scanning, but has the disadvantage that a fast moving target may pass entirely through the field of view while the lookouts are scanning in another direction.

5. Data Needed. As yet it has not been possible to carry out the complete calculation of the detection curve in any single case. Before this can be done, many more data will be needed. There are two possible methods of obtaining these data, and it would be desirable to have both so that they could be checked against each other.

The first method is by the extension of the laboratory data. Craik's data apply only to one background brightness (530 foot lamberts in his threshold contrast measurements. His scanning experiments were conducted at an unknown level of illumination). With further data on radii of the perceptive area, the scanning lobes could be constructed for all the important cases. Further work on chance of detecting a target inside the perceptive area is also desirable. Then the optimum scanning procedure could be worked out, and the detection curve for this procedure found.

The second method is more direct, and consists of carrying out actual scanning tests against targets of fixed size and contrast. When enough data are obtained to give the pick-up time as

a function of target size and contrast, for a variety of backgrounds, then the calculation of the detection curve becomes a straightforward problem in mathematics.

Discussion:

Comdr. Bittinger asked whether binoculars have been adapted for use in aircraft. He suggested that more effective air-sea search would be possible if binoculars with a large field and low magnification were used, and the men trained to use them. He pointed out that the first model of a binocular employing different magnification and size of field for each eye has been developed. It is designed so that a target can be picked up with the larger field (magnification 3X) and then identified with the higher power lens (10X). The difficulty with this model has proved to be in getting both barrels on the target at once.

Comdr. Leavitt said that binoculars have not proved advantageous in trials and experiments to date. The unaided eye with a filter picks up the target just as fast as with a binocular. The suggestion has been made, however, that a rigidly mounted swivel chair be incorporated in sea-search planes to make possible fast scanning with fixed instruments and binocular aid. It is believed that a more effective scanning arrangment would result from supplementing, in this way, the regular lookout, scanning slowly with the unaided eye. Lt. Nolan suggested that the scanning chairs developed by Division 16, NDRC, might be modified for this use.

Comdr. Leavitt pointed out that an extensive series of tests will be conducted in the near future by the Bureau of Aeronautics to determine the visibility of various kinds of rescue signalling equipment and various sized rafts for different conditions of viewing. The rate of scanning is important because the size of the signal is critical; so little equipment can be made available on a liferaft that a choice might have to be made, for example, between one higher candle-power red star signal and two low power ones produced a few seconds apart.

Lt. Col. Feldman suggested the use of trailing smoke signals; they are lasting and give the direction from which the signal emanated. Comdr. Leavitt explained that such signals have already been tested, and it was found that thin lines of trailing smoke are not sufficiently visible to be effective. Orange smoke signals seem to be best for clear atmosphere, and red stars have the advantage in conditions of overcast. More experimental evidence is needed on this problem, however.

Dr. Marquis asked if the visual lobe described by Dr. Kimball is a circle on planes perpendicular to the line of gaze and onion-shaped when projected on the sea. Dr. Kimball explained that

the change of visual angle at distance and the effect of haze in the atmosphere caused the change in the shape of the lobe. In answer to Dr. Marquis's question concerning the effect on the visual lobe of the use of binoculars, Dr. Kimball said that binoculars primarily increase the visual angle of the target. They give a longer range but at the same time decrease the lobe as a whole by the same magnification. The gain in range is accompanied by a necessary slowing down of the scanning process. The importance of this effect depends on the kind of target and the time for scanning; if there is plenty of time to scan, and it can be done slowly, binoculars may be of aid.

Dr. Marquis described a device proposed by Lt. Comdr. Dyke and now being considered by the Navy Bureau of Aeronautics. An observer may be confused by the blur of target objects seen from a high speed plane flying at low altitude. By means of a tilting mirror arrangement, he can see a stationary reflected image of the sea surface in a second mirror. This image would then shift to the adjoining sea area as the tilting mirror snapped back to its original position. Dr. Kimball felt that there was no clear requirement for this device under ordinary operating conditions.

5. EFFECT OF GREEN SIGNAL LIGHT ON DARK ADAPTATION

Digest of discussion:

Lt. Comdr. Dyson requested an opinion from the Committee on the following problem: In gun turrets during night operation a small red light is used to indicate when the guns are in a danger sector, and a green light is used for the safe position. Will the green light affect dark adaptation to a material degree? What shade of green should be used? Is there enough difference between orange and red to use orange instead of green?

Dr. Hulburt thought that if weak green light were used, it would not interfere with dark adaptation, especially since one brief glance at the light would be sufficient. Data are available on the effect of various wavelengths on dark adaptation, but it is difficult to apply them precisely to a given problem unless all of the conditions are known.

Dr. Duntley suggested that the red light be made to blink in the danger zone. Mechanical difficulties might make this impossible, but it would be optically effective.

Lt. Pulling suggested two intensities of red light, bright for the danger zone and weak for the clear. Lt. Nolan thought that an orange or yellowish orange light for the safe position would be best. The contrast would be sufficient. Other suggestions included using lights of different sizes, shapes, and in different positions.

There was general agreement that a dim, small, green light would not materially affect dark adaptation, but that an orange light would be preferred, provided there is no confusion with red under the conditions of its use.

ABSTRACTS

43. MEASUREMENT OF PARAFOVEAL FIXATION AT LOW BRIGHTNESSES

Craik, K. J. W., M.R.C. Applied Psychology Unit, Psychological Laboratory, Cambridge, Report No. A.P.U. 11, 5 December 1944, 3pp. (restricted).

A method of measuring the degree to which observers fixate objects parafoveally at low illuminations is described. It involves flashing a bright point-source of light in the center of the object which they are trying to see against a background of 0.0001 e.f.c., so that a positive after-image is formed on that part of the retina. The subject is then asked to fixate a red dot in the center of a target and to report the position of his after-image on the target.

The mean angle of parafoveal fixation for 12 RAF personnel trained in night vision was 3° and for 18 untrained men $2\frac{1}{2}^{\circ}$, which are not significantly different, and show a considerable natural tendency to indirect fixation. Rough measurements of visual acuity at greater parafoveal angles suggest, however, that an increase in visual range of 10% or 20% might be achieved by further efforts at parafoveal fixation.

44. PRESENT STATUS OF GOGGLE AND SUN GLASS EQUIPMENT

Pinson, E. A., Aero Medical Laboratory, Wright Field, Memorandum, December 1944, 6pp. (confidential).

This memorandum summarizes the status of development, test, procurement, and use of goggles and sun glasses in the Army Air Forces. Current work includes consideration of sun-scanning goggles and attachments, improvement of the B-8 goggle suspension and field of view, and design of a goggle for emergency kits.

45. DRUG #MI

(From a CinCPac-CinCPOA special translation, 10 November 1944, confidential, of a document captured from the Japanese during the occupation of Saipan.)

Drug #MI consists of concentrated vitamin A and Special Compounds and has the effect of increasing visual acuity by stimulating the liver and thus accelerating absorption of vitamin A and fatty acids. After taking Drug #MI, night vision is increased 50-100%, and furthermore, the time required for night accommodation is shortened. Although the effects of Drug #MI appear after one day's use, maximum effect is obtained after taking the drug for two days. Its effects will continue for 3 days after its application has been discontinued. It has the additional effect of increasing strength and preventing fatigue. It is taken internally, 3 doses after each meal. (9 doses per day). Several laboratory and field tests showed that the drug approximately doubled the range at which targets could be seen in low illumination by either trained or untrained men.

46. RADAR OPERATOR "FATIGUE": THE EFFECT OF LENGTH AND REPETITION OF OPERATING PERIODS ON EFFICIENCY OF PERFORMANCE

Lindsley, Donald B., et al., Applied Psychology Panel, NDRC, Project SC-70, NS-146, Research Report No. 6, 4 January 1944, 22pp. (confidential).

The purpose of this study was to determine whether long and repeated periods of operation of an A-scan oscilloscope result in loss of efficiency in performance or so-called "fatigue effects". Secondly, it was desired to know when impairment of performance begins and what relationship it bears to the length and frequency of repetition of operating periods. Because of its significance in the successful operation of air-warning radar sets, the ability to detect signals (especially weak signals) on an oscilloscope screen has been taken as one measure of performance efficiency. Another criterion of efficiency which has been studied is the accuracy of determining the azimuth or bearing of target echoes. Failure to detect or to locate signals accurately is a sign of inefficiency; the greater the number of signals omitted or the greater the error in location, the greater the inefficiency.

Under conditions closely simulating those of the actual radar screen in field operation, the ability of 8 men previously trained to a high level of proficiency was tested during four-hour periods of continuous scope operation on successive days for a period of approximately three weeks.

1. Daily repetition of a four-hour period of A-scan oscilloscope operation caused a progressive loss of efficiency in the detection of signals and in the accuracy of determining the azimuth or bearing of targets represented by the signals.

2. Loss of efficiency was related to the length and repetition of the operating periods and revealed itself by an increase in the number of signal omissions, an increase in the rate of making omissions, a decrease in accuracy of azimuth or bearing determinations, and by a general increase in variability of performance.

3. Impairment of performance first became significant with repeated operating periods of forty minutes in duration for a group operating in the morning and at the end of the second hour for a group operating in the afternoon.

4. Loss of efficiency did not become apparent until the third day of repeated four-hour operating periods. This may indicate that occasional prolonged periods of operation may be served without appreciable loss of efficiency. This conclusion is not entirely unequivocal, since factors of initial adjustment to the four-hour period of operation and of learning may have masked fatigue effects.

5. In general, therefore, to insure the most efficient performance it does not appear wise to prolong daily operating periods more than forty minutes if such periods of operation are to be repeated daily without intervening days of rest. On the other hand it is possible that occasional operating periods of as much as four hours in duration may be tolerated without marked reduction in efficiency.

47. EFFECT OF OSCILLOSCOPE OPERATION ON VISION

Lindsley, Donald B., et al., Applied Psychology Panel, NDRC, Project SC-70, NS-146, Research Report No. 4, 15 November 1943, 13pp. (confidential).

Rumors that continued work before an oscilloscope damages the eyes are prevalent among radar operators. The purpose of this study was to determine whether oscilloscope operation actually has a deleterious effect on vision. In order to answer this question the visual capacities of radar operators were compared with those of a control group of non-operators and the visual capacities of operators of long-term service with those of operators of short-term service. Vision was tested with the Bausch and Lomb Ortho-Rater.

1. A comparison of the visual capacities of 244 radar operators with those of 112 young men who had not spent time working before an oscilloscope revealed no significant differences on any of the Ortho-Rater tests, which included measures of visual acuity, vertical and lateral muscle balance, depth perception and color vision.

2. There were no significant differences in visual efficiency between a group of 58 veteran operators (18 months experience or more) and a group of 52 short-term operators (2 months experience or less).

3. The results of an analysis of the visual histories and present ocular complaints of the operators tend to support the test findings. Symptoms were reported no more frequently by veteran operators than by inexperienced operators.

4. A complaint among operators was that if they remained at the oscilloscope "too long" (2 to 3 hours or more) they sometimes suffered ocular fatigue, eye strain, headaches and other symptoms of ocular distress. It was usually agreed that similar symptoms occurred if they read "too long", hence the complaint was not specific to oscilloscope operation.

5. The results indicate that radar operation does not impair visual efficiency. It is recommended that operators be informed of this fact in order to allay any persistent fears they may have with regard to deterioration of vision.

48. VISUAL STATUS OF ASV RADAR OPERATORS

Lindsley, Donald B., et al., Applied Psychology Panel, NDRC, Project SC-70, NS-146, Research Report No. 9, 20 March 1944, 7pp. (restricted).

In a previous report by this project, data were presented indicating that operators of air-warning radar oscilloscopes do not show any deterioration in visual capacities, as measured by the Bausch and Lomb Ortho-Rater. A similar study has been carried out on ASV operators using three different types of scopes. In general, the type of service rendered by these two groups differs in that the air-warning operators are at the scopes more frequently, but for shorter periods of time than the ASV operators. The latter may have experienced the necessity of continuous operation of as much as 12 to 16 hours duration, although operating periods usually vary from 4 to 8 hours. It was thought worthwhile, therefore, to investigate the visual status of these search operators, in view of the possibility that the additional length of operating period might produce deleterious effects.

A group of 66 ASV oscilloscope operators show no significant differences in visual acuity or muscle balance when compared to a group of 112 non-operators. Furthermore, 19 men, the most highly experienced operators in the group, with 500 or more hours in the air failed to show deleterious effects of long continued operation.

49. VISION AS RELATED TO PROFICIENCY IN OSCILLOSCOPE OPERATION

Lindsley, Donald B., et al., Applied Psychology Panel, NDRC, Project SC-70, NS-146, Research Report No. 8, 24 February 1944, 10pp. (restricted).

The vision of 73 short-term and 84 long-term operators was

tested with the Bausch and Lomb Ortho-Rater. Ratings of operator proficiency were also obtained. A study of the relationship between the ratings and the visual measures showed the following:

1. Operators of short-term experience with sub-standard binocular visual acuity at near were rated significantly lower than those with standard or better acuity.

2. Short-term operators with excessive over-convergence at near were rated significantly lower than those with normal convergence.

3. The results for long-term operators support those for the short-term operators with respect to visual acuity, but not over-convergence. The experienced operators were a more highly selected group.

4. Far visual acuity, far lateral phoria, and stereopsis were not significantly related to the ratings of performance in either group.

5. Scores on the color vision test were significantly related to the ratings of short-term operators, but it is questionable whether color vision *per se* is important for radar operators. It is more likely that the relationship is a function of the perceptual discrimination which this particular test requires.

6. Vertical phoria occurred so infrequently in both groups that its importance could not be evaluated.

7. The present results indicate that tests of binocular acuity (near) and vertical phoria (near) should be utilized in the examinations for prospective radar operators. It is recommended that minimum standards be set at 1.0 (decimal notation) for the near acuity test and at 6 prism diopters of over-convergence or esophoria.

8. The Ortho-Rater is an excellent instrument for making the test since it provides reliable measures of vision at the near or working distance and requires less than ten minutes of testing time.

50. A FOLLOW-UP STUDY OF THE EFFICIENCY OF THE PROJECTION EIKONOMETER TEST IN PREDICTING THE PERFORMANCE OF STEREOSCOPIC HEIGHT FINDER OBSERVERS

Beier, D. C., Florence Gray, H. A. Imus, and E. B. Knauft, Applied Psychology Panel, NDRC, Project N-114, Research Report No. 13, 21 November 1944, 11pp. (restricted).

Former research (Brown University Report No. 4, OSRD Report No. 1790) showed that when a Projection Eikonometer score of 115 is

used as the stereoscopic performance selection standard for Height Finder Operators, there is a significant decrease (from 32.6% to 7.1%) in the percentage of failures in height finder performance as measured by the variability score and combined score. The present study shows that approximately the same low percentage of failures (7.9%) results when the Projection Eikonometer is used as the final selection instrument at the recommended cut-off for subsequent classes.

51. AN INDEX TO RESEARCH REPORTS ON VISUAL PROBLEMS FROM THE AERO MEDICAL LABORATORY

Aero Medical Laboratory, Air Technical Service Command, Wright Field, Dayton, Ohio, 1 January 1940 - 1 January 1945, 58 reports, not classified.

Areas of visual research at the Aero Medical Laboratory include: (1) development, test, and standardization of all goggles, sun glasses, and eye protective devices for the AAF, (2) fields of vision and distortion in transparent sections of aircraft, and (3) night vision studies

52. THE STILES-CRAWFORD EFFECT AND THE DESIGN OF TELESCOPES

Jacobs, Donald H., J. Opt. Soc. Am., 1944, 34, 694

Classically it has been assumed that the perceived brightness of the image of a point object viewed along the axis of a telescopic system is proportional to pupil area. Because of the Stiles-Crawford effect, this assumption is to some extent in error; a smaller exit pupil will be relatively more effective than is suggested by the ratio of exit pupil areas. A table has been prepared giving the relative effectiveness of various pupil diameters according to classical theory, and the actual relative effectiveness based on the analytic expression of the Stiles-Crawford effect proposed by P. Moon and D. E. Spencer (J. Opt. Soc. Am., 1944, 34, 319). The Stiles-Crawford effect is observed for all brightness levels when foveal fication is used. For parafoveal fixation at high brightness levels, predictions taking into account the Stiles-Crawford effect are also valid. For parafoveal viewing at low brightness levels, the Stiles-Crawford effect does not hold, and judgments of relative perceived brightness are based on pupil area.

Pupil diam. mm.	(Pupil diam.) sq. mm.	Relative area	Rel. eff. flux	Effective flux, F_e
1	1	2.0	3.5	0.78 D
2	4	8.2	13.5	3.01 D
3	9	18.4	28.7	6.40 D
4	16	32.7	47.3	10.57 D
5	25	51.0	67.0	14.93 D
7	49	100.0	100.0	22.31 D